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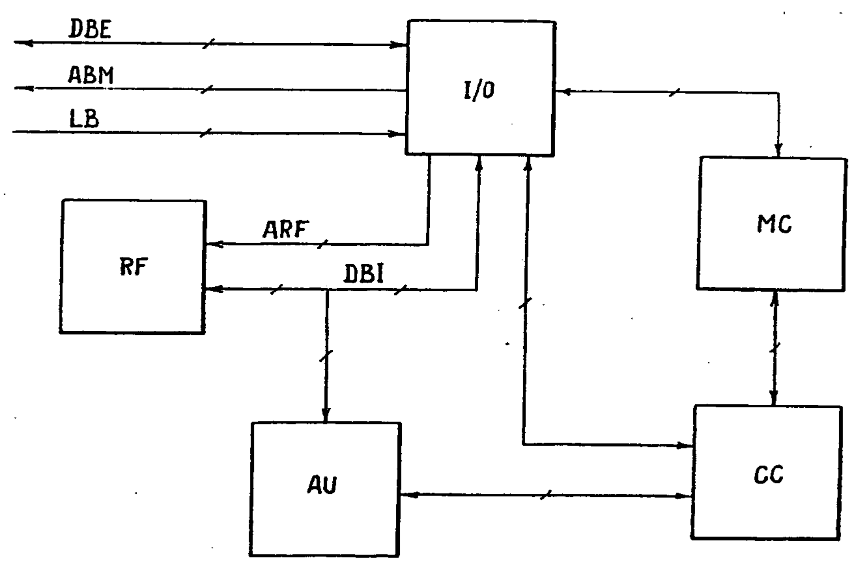

(57) Abstract

Method for the control of the cell flow in a telecommunication system in ATM technique, according to the so-called "Leaky Bucket" principle, where to each active connection (VC/VP) a current value (VLB) is associated, increased by a first quantity (INC) and decreased by a second quantity, following the arrival of an information cell relating to the connection. Said value (VLB) is compared with a reference threshold (S) to decide if the cell has to be sent or not. The decrease is equal to the product of a third quantity (DEC) and the difference between the absolute time (CLK) and the time (LST) of the previous updating of said current value (VLB). The method is implemented by means of one unit (PU) including two control units (CC, MC), an arithmetic unit (AU), a register file (RF) and an input/output unit (I/O).

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METHOD AND UNIT FOR THE CONTROL OF THE CELL FLOW IN A TELECOMMUNICATION SYSTEM ACCORDING TO THE ATM TECHNIQUE

The present invention refers to a method for the control of the cell flow in telecommunication systems employing a particular numeric technique, called ATM (Asynchronous Transfer Mode), for the transmission and/or communication of voice and video signals and data.

In the ATM technique, data relevant to different users and services are organized as timely contiguous units with a fix length of approximately 400 bits, called cells. Cell bits are subdivided into a field containing information to be exchanged, and in a header, containing information necessary to the cell routing through the switching network and other service information.

The ATM technique is considered as the most promising solution for multiplexing and switching, in the evolution of public communication networks towards the future broad band integrated services digital network (B-ISDN), since this technique allows a great flexibility versus the previous (circuit switching) systems.

A given number of connections, called Virtual Channels (VC) and Virtual Path (VP) can be active at the same time on an ATM link. The virtual channel is a logic association between terminal points of a link enabling the unidirectional cell transfer on that link, while the virtual path is a logic association of virtual channels between the terminal points of a link enabling the unidirectional transfer of cells belonging to a group of virtual channels existing on that link [see also CCITT Rec. I.113]. A varying number of virtual channels and/or virtual paths (VC/VP) can be associated to each user or to each call, because a same ATM user could have several calls established at the same time and each virtual channel can require a special number of cells in the time unit, thus obtaining a very high flexibility of the network in the management of data.

In particular, the allocation of network resources can be made on the basis of what is actually required by the user, thus allowing a high effectiveness particularly in the case of connections requiring variable network resources.

However, due to the fact that the ATM technique is of the asynchronous type and subject to considerable use variations by users (in a wide sense), it is necessary to monitor the flow of cells sent to the switching network of the ATM system to prevent the overloading of the same and particularly an overload ascribable to transmission by users of a number of cells higher than that agreed with the network operator, on which basis the necessary network resources are allocated to the call and the accounting is made for the use of the network itself. In this case it is defined a "band width" higher than that agreed with the network operator.

This control is called UPC (Usage Parameter Control) in ATM environment and can take place depending on one of more flow parameters, generally tied to the "frequency" or more particularly to the bit rate, that is to the number of bits transmitted in a given time interval.

To this purpose users connected to the network can be divided on the basis of the service required which can be at Costant Bit Rate (CBR) or at Variable Bit Rate (VBR). In the case of CBR services the characteristic of the connection are sufficiently identified by a single parameter, i.e. the agreed bit rate, while in the case of VBR services two parameters at least have to be considered, for instance the ripple Rp bit rate (measured on a short time period) and the medium Rm bit rate (measured on a longer time period).

A method for the control of the flow in an ATM netword can be that to foresee the control or monitoring of the bit rate agreed for each CBR connection (or user) coming into the switching network and the ripple bit rate for each VBR connection, excluding the cells in excess of these values.

This solution is acceptable for CBR connections, but it results too rigid for VBR ones, compromising a great part of the advantages of an ATM network.

The solution proposed for VBR connections is therefore to eliminate exceeding cells according to given criteria which consider also the average bit rate, agreed by each network user and the network operator, besides the ripple one.

A method for the control of traffic parameters agreed upon between the user and the network operator, which was proposed in ATM environment, is the so-called "Leaky Bucket". This method is shown in Fig. 6 and can be considered from the conceptual point of view as including a counter CN, counting the IN input cells (with an assigned header), and which is increased at each cell input and periodically decreased by a Clock signal, whose frequency is defined on the basis of the value agreed for the traffic parameter to be controlled. The counter output is connected to the input of a comparator CP, receiving on the other input a reference threshold value (stored in a TH register being it also a function of the value agreed for the traffic parameter to be controlled), and emitting at the output a control logic signal of a SW switch, rejecting the cell or letting it go on.

Until the CN counter value is lower than the value assigned for the threshold, cells coming from that connection are accepted, that is routed to the network. When the counter content exceeds the threshold value, the cell is rejected since the user has sent a number of cells higher than the one agreed upon.

This method enables to control the agreed Bit Rate, suitably fixing the decrease frequency of the counter CN and the threshold value TH. In particular, in this case the "Leaky Bucket" mechanism is used to control the average Bit Rate of a VBR connection, it results that the threshold value TH is much higher than that for the control of the ripple Bit Rate of a VBR connection (or of the Bit Rate

defining the connection, if this is of the CBR type), since the user behaviour has to be averaged on a long enough time period.

However, the method described hereabove has some inconvenience and limit for use in an ATM network, due to the fact that control has to be extended to all VC/VP (virtual channels/virtual paths) which can be active at the same time on a given ATM link. In fact the Leaky Bucket mechanism acts on the basis of the traffic parameter value agreed for the VC/VP, therefore a counter CN and a register TH has to be assigned to each active VC/VP and each CN counter has to be decreased in a differentiate mode at the frequency defined for each VC/VP, and therefore the above described device becomes quickly complex due to the high number of VC/VP which can be active at the same time on a link.

The scope of this invention is therefore to implement a method and a control unit capable to eliminate the above mentioned inconveniences and limits for the former technique.

The invention consists of a method for the control of cell flow according to the so-called Leaky Bucket principle in ATM technique telecommunication system, where a current value is associated to each active connection, increased by a first quantity and decreased by a second quantity, following the arrival of an information cell relating to said connection, said value being compared with a reference threshold to decide to send or not the cell, characterized by the fact that said decrease is equal to the product of a third quantity for the difference between the absolute time and the time of the previous updating of said current value.

The invention consists also of a unit for the control of information cell flow in ATM technique telecommunication system, characterized by the fact to include:

an arithmetic unit connected to an input/output unit through an internal data bus, said input/output unit being connected to an external data bus;

a register file connected to said input/output unit through said internal data bus and an internal address bus, and connected to said arithmetic unit through said internal data bus;

a first central controller supervising the updating operations, and a second memory controller for the control of the loading/storage sequence.

The invention consists also of a unit at the input of an ATM technique telecommunication system for the control of the cell flow through a unit as described above, characterized by the fact to include a storage containing the so-called Leaky Bucket parameter values relevant to active connections, each address block containing a record made of status fields, one current value field, a field containing the value associated to the parameter to be controlled for the relevant link and a field containing the time of the last updating of the current value field of the relevant connection.

Further advantageous characteristics result from the ensuing claims.

The invention shall now be described making reference to a preferred, but not limiting, realization form, shown referring to the enclosed figures, where:

Fig. 1 shows a diagram of the ATM connection network and the central unit terminations connected to the same;

Fig. 2 shows a diagram of some units forming part of the exchange termination unit (ET), including a control unit according to the invention;

Fig. 3 shows more in detail the connections to the control unit according to the invention;

Fig. 4 shows a construction of the control unit according to the invention;

Fig. 5 shows the structure of data in the memory, and

Fig. 6, already considered, shows the known control principle of cells called Leaky Bucket.

Referring to Fig. 1, an ATM switching node includes a connection network SN, to which different exchange termination units (ET) are connected, receiving incoming cell flows IN/F and transmitting outgoing cell flows OUT/F, correctly routed to the SN network.

These input and output flows can take place through an ATM link, for instance having a capacity of approximately 156 Mbit/sec. A given number of virtual channels and virtual paths, called in short hereafter VC/VP, can be active on this link.

An ET structure, upstream side (that is towards the SN network) is shown more in detail in Figures 2 and 3. It includes a HTU assembly (Header processor and Translation Unit) receiving the incoming flow, processing the cells at ATM level and transforming the cells from the ATM standard format to proprietary format internal to the node, before these are (possibly) sent to the SN.

The control of the flow at the ATM node input is carried out at this level, in cooperation between HTU and a PU unit (Policing Unit), present also in the ET, having the specific task to verify the compliance of VC/VP behaviour with the parameters agreed between the user and the network operator during the call set up phase. The non conformity or infringement can determine the elimination of the cell or its marking for further evaluation on its accessibility in the network.

The elimination and/or marking of cells infringing these parameters are actually made by the HTU since, according to the invention, PU does not directly receive the incoming cell flow, but it is connected to the HTU unit through a four-wire interface on which four signals are exchanged, marked SP, SV, PO and EP, and through an LB bus for the communication of virtual path (VP) and virtual circuit (VC) identifiers of the incoming cell.

Should the PU unit detect a non compliance, it gives the answer to the HTU in due time for the cell is rejected (or marked) by this unit, before it is sent to the network. This procedure performs, from the conceptual point of view, the function of the schematic arrangement, shown in Fig.6, of a controlled switch SW to reject cells in excess.

The PU unit has an associated dedicated RAM memory, called MPU, containing the so-called values of Leaky Bucket parameters relating to active connections. For instance, matching each address, these values include the counter value and the threshold value associated to a given link. The MPU memory is able to contain, e.g. 2048 addresses (2^{11}), each including 8 bytes, totalling 16384 bytes (2^{14}).

Therefore the counter, which according to the Leaky Bucket method is increased, decreased and compared with a threshold value, is here replaced by the content of a PU register where the content of a given location of the MPU memory is loaded for these operations.

As it can be better noticed from Fig. 3, the interface between HTU and PU foresees two wires for each direction, and particularly two wires for SP and SV signal for the possible activation of the control procedure from HTU to PU, and two wires for EP and PO signals for acceptance indication.

Particularly, SP is the starting signal informing the PU to carry out the control on the cell identified by the VCI/VPI or other identifier, made available to the PU on a LB bus (Label Bus), while SV is the validation signal; PO is the output signal which communicates the result of the control to HTU, and EP is the validation output signal of PO. Matching each cell, SV and EP strobe signals are used to perform a four-phase asynchronous protocol between the HTU assembly and the PU unit, irrespective of the presence or not of a cell to be controlled. The interface is of the general type and allows an easy coupling of the PU with other components, in other points of the network, where the

engaged band width control can be required (e.g. at the input of an ATM statistic multiplexer, etc.).

Therefore, according to the invention, to control all VC/VP active at the same time on the ATM link, which can also be thousands on a same exchange termination unit (ET) of the public network, a central device is employed, connected to a memory in whose addresses counter contents are allocated, each one of them being updated at the arrival of the corresponding cell.

In the first model of Leaky Bucket the decrease operation of counters is made separately for each VC/VP with a frequency set by the Clock dedicated to the same. However, this method has the disadvantage to have to make, in the same cell time, the decrease (updating) of counters for a number of VC/VP which cannot be foreseen before, theoretically even up to a maximum of all VC/VP active on the link at the same time.

According to the invention, the PU performs the control of the cell flow of all VC/VP active on the link at the same time, in an independent way, performing the updating of the "virtual counter" of a single VC/VP at each cell time, instead of a plurality of VC/VP as specified above. This is performed making the updating of the VC/VP counter only at the arrival of the cell relevant to it, according to the following formula:

$$VLB = VLB + INC - (CLK - LST) \cdot DEC \quad (1)$$

where the variables have the following meanings:

- VLB is the filling current value of the Leaky Bucket associated to the particular VC/VP. It is contained in a portion (see Fig. 5) of the address location in the MPU memory corresponding to the special link, from which it is drawn up for updatings, and where it is brought back after any updating.
- INC is the value by which the current value VLB is decreased when a new cell of that connection arrives.

Preferably this value is not a unit value, but it is always a higher one. For instance it can reach a maximum value of $(2^{16}-1)$.

- DEC is the value by which the counter is decreased at each cell time, which can be freely selected from 1 and INC.
- CLK is the absolute time, which is increased by one unit with a period equal to the ATM cell duration (that is every 2,83 μsec approx. for the 156 Mbit/s link).
- LST is the time of arrival of the last cell relevant to a given link. Therefore LST is assumed equal to CLK when the new cell is accepted because it does not infringe the controlled parameter, and in general (CLK-LST) indicates the time elapsed from the last updating of the current value VLB relevant to the link under consideration.

A possible and preferred realization of the PU unit is given in Fig. 4.

The PU unit shown in Fig. 4 includes five main units, and more in particular a controller MC and a controller CC, an arithmetic unit AU, a file or register file RF, and an input/output I/O unit.

The central controller CC supervises updating and refresh (described here after) operations, while the memory controller MC has the function to control the loading and storage sequence to and from the MPU.

The arithmetic unit AU, where updating and refresh operations are actually made, includes two 16 bit records, two 8x8 multipliers to make a multiplication between two 16-bit binary numbers, and two arithmetic-logic units (ALU) suitable for 32 bit arithmetic operations.

The register file RF is used to contain the Leaky Bucket parameters for link classes, as defined herebelow. The file is made of one storage unit, where on initialization, Leaky Bucket parameters are written, read by preset locations of the MPU. This memory is addressed through the address bus ARF and data addressed to, and coming from the same, transit on the internal data bus DBI.

The input/output I/O unit connects the external data bus DBE for the connection with the MPU to the internal data bus DBI, it controls the ABM address bus for the MPU external RAM on MC control and the ARF address bus on CC control.

Fig. 5 shows the organization of an address block of the MPU memory. Each address block or data record contains the current parameters for the execution of the control method. Fields are the following:

VLB Field: it is a 28 bit field containing the current value of the counter indicating the Leaky Bucket filling; it is updated according to (1), at the arrival of a new ATM cell from the relevant connection, only if the cell complies with what agreed, or to each refresh operation relevant to that address.

The VLB value is updated only when a corresponding cell arrives. In case the updating results in a negative value, VLB is assumed equal to zero. The upper limit of this value is a threshold S: if the updating underway involves the overcoming of the threshold value, an infringement is signalled and the VLB value is not updated.

INC/DEC Field: it is a 16 bit read only field for the PU, containing the value associated to the parameter to be controlled for the relevant VC/VP.

LST Field: it is a 16 bit field and contains the CLK value corresponding to the last updating of the VLB value. When an infringement is detected, LST is not updated, according to what said above.

Status Field ST: it is a 4 bit field where the new call information is stored, through the NC bit, having value 1 for the first cell of each VC/VP, in such a way that PU initiates the VLB value at S/2; the class of the connection underway CC0-CC1 defining the threshold and increase/decrease values; and the VD bit whose function shall be described later on.

Since the increase and the decrease of the VLB value relevant to VC/VP are made only at the arrival of the

corresponding ATM cell, the result of this updating operation depends on the time elapsing from the arrival of two consecutive cells belonging to the subject VC/VP, as indicated in (1). The time elapsed from the arrival of the last cell is obtained as difference module-n between CLK and LST, if these are represented on n bits.

If a VC/VP allows too time elapse between two cells, the counter generating the CLK signal could make a complete module-n count without the updating of the LST value, and therefore an overflow condition could occur, that is the subsequent cell of said VC/VP, arrived after a complete tour of the counter CLK, is considered as arrived after the previous one since CLK and LST values result being close, and (CLK-LST) results to be small. It could occur that users, who employ a reduced and irregular band width, that is who send cells with a comparative low and/or irregular rithm, see their cells suppressed due to the overflow effect, with an ensuing different treatment among users, and particularly punishing just the connections having lower frequencies.

The increase of counter sizes is only a partial solution of the problem, since there are some limits to this extension, and worse than that, with a very long counter cycle, the penalization deriving from the possible cell suppression is even higher.

According to the invention, a periodical re-writing or refresh of VLB and LST values of each link is foreseen, where the datum is re-written as decreased by the time elapsed. More particularly, at each cell time, equal to 2,83 μsec (averagedly) in the example considered, the value relevant to a VC/VP is modified according to the following relation:

$$VLB = VLB - (CLK - LST) \cdot DEC \quad (2)$$

where the variables have the same meanings described for (1).

This updating is made in succession for each VC/VP. In other words, compared to the relation (1), governing the control, INC is not added because no cell has arrived, but VLB is decreased by (CLK-LST) . DEC and VLB and LST values are updated in the MPU memory, considering in this way only the time elapsed from their last updating.

In pratice, in a cell time, refresh of values relevant to a link is made first, applying the relation (2), and then, if a cell arrives, the actual verification is made, applying the relation (1) to the parameters relevant to the VC/VP belonging to the cell arrived.

It must be noticed that, in principle, the refresh operation intervenes on the values contained in an address of the MPU memory different from the one being the object of the control operation. Occasionally, it can occur to make a refresh operation in the same cell time, followed by a control operation on the values relevant to the same VC/VP, or contained in the same MPU address. In this case, the result of the two subsequent updatings of VLB is equal to the one which can be obtained with a single updating, applying only the relation (1), and therefore the refresh operation is completely transparent to the user of the ATM network.

If a 2^n address MPU memory was foreseen, the complete updating of all VC/VPs should take place after 2^n cell times or CLK increases. Due to the fact that VC/VPs active at the same time on a same link could be even more than 2000, n can have to be higher than 11; preferably, the CLK counter, and therefore LST, are selected of the 16 bit length, that is each one of the variables CLK and LST is 16 bit long. With this choice the upper limit of the MPU maximum dimension, which is 2^{16} addresses maximun, results far beyond practical requirements for use.

To prevent overflow it is sufficient to perform the refresh operation with an intervention frequency not higher than the overflow cycle time (equal to 2^{16} cell time), and therefore the device runs for whichever equipment of the

MPU memory not higher than the above mentioned maximum dimension.

Preferably, according to the invention, VC/VPs active at the same time on the link are subdivided into classes or groups and the classification of VC/VP into one class is indicated by the CC value (Connection Class) contained in the MPU at the address corresponding to the VC/VP. The class is selected during the link establishment phase and therefore the CC value can be programmed according to the final contract stipulated with the user. Also DEC value is programmable according to the final contract with the user. On the contrary, the INC value and the threshold value S can be programmed according to the class. It is thus possible to save space in the memory, because an INC value and an S value for each VC/VP have not to be stored in the MPU, but only the CC value to identify the relevant class.

In this case DEC is proportional to the Bit Rate one wants to control and INC corresponds to the number of equal intervals into which the link band width is divided and therefore it depends on the minimum value of band width which can be allocated and controlled. For instance, having INC represented on 16 bits we can discriminate among Bit Rates differing of about 2 kbit/s.

An alternative realization is to maintain the INC value programmable according to the contract stipulated with the user, while the DEC value is made programmable according to classes. In this case INC is proportional to the Bit Rate to be controlled and DEC corresponds to the width of intervals into which the link band width is divided, and therefore it conforms to the minimum band width we can allocate and control, that is DEC = 1 corresponds to a 2 kbit/s band width, for the 156 Mbit/s link, if the maximum dimension of INC (and therefore of DEC) is equal to 16 bits.

As an indication, without limiting the scope of the invention, the number of classes has been selected equal to

4, therefore the CC value results represented on 2 bits CC1 and CC0, as shown in Fig. 5.

According to the invention, the PU unit can be programmed to operate in Single Mode (SM) or in Parallel Mode (PM), through polarization of the S/PM input shown in Fig.3. SM operation has been described herein before.
On the contrary, the operation in PM, the PU unit controls an indication coming from the outside. This indication comes to the EPOK and EEP inputs represented with dotted lines in Fig.3.

The information relevant to the non acceptance of the cell due to events out of the subject PU control (e.g. infringement of parameters controlled by other PU or other type units), is given to the EPOK input, while the signal validating EPOK is given at the EEP input.

The PU evaluates the EPOK signal only if it has not detected the violation i.e. when it supplies at the output PO=1. In this case, if the PU finds EPOK=0, in correspondence of the EEP rising edge, it stores VD=1 in the status field ST of the MPU memory (see Fig. 5), at the address relevant to the VC/VP, which the considered cell belongs to, otherwise it stores VD=0. Therefore:

if PO=1 and EPOK=1, it results VD=0;

if PO=1 and EPOK=0, it results VD=1;

if PO=0, EPOK is not considered and VD is not modified.

Each time PU is activated by HTU to perform the cell control (SP=1 in correspondence of the rising edge SV), it updates the VLB value according to the VD value stored in the MPU memory in the following way:

1. with VD=0, PU applies the formula (1), as in Single Mode operation;

2. with VD=1, PU updates VLB without increasing the value of INC quantity, since it has already made this increase on the arrival of the preceeding cell of the same VC/VP, which was rejected by HTU due to events independent from the PU under consideration. Therefore the formula (2)

is applied, and therefore we can talk of refresh like algorithm.

The refresh operation is not affected by the Single/Parallel Mode operation, and in the Parallel Mode it is performed as previously described.

Though the invention has been described making particular reference to preferred realization forms and application methods, it is not limited to what described, but extends to cover all the obvious variations and/or modifications which shall be evident to the technicians in this field.

CLAIMS

1. Method for the control of the cell flow in an ATM technique telecommunication system, according to the so-called Leaky Bucket principle, where to each active connection (VC/VP) is associated a current value (VLB), increased by a first quantity (INC) and decreased by a second quantity, following the arrival of an information cell relating to said connection, said value being compared with a reference threshold (S) to decide to send or not the cell, characterized by the fact that said decrease is equal to the product of a third quantity (DEC) for the difference between the absolute time (CLK) and the time (LST) of the previous updating of said current value (VLB).

2. Method according to claim 1, characterized by the fact that said updating occurs only on the arrival of a new cell relevant to said connection, if this did not cause an infringement.

3. Method according to claim 1, characterized by the fact that the value of said threshold (S) is variable.

4. Method according to claim 1, characterized by the fact that the value of the first quantity (INC) is variable.

5. Method according to claim 1, characterized by the fact that the value of the third quantity (DEC) is variable.

6. Method according to claims 3, 4 and 5, characterized by the fact that the values of the threshold (S) and of the first quantity (INC) can be programmed according to the connection class and said value of the third quantity (DEC) can be programmed according to the connection.

7. Method according to claims 3, 4 and 5, characterized by the fact that the values of said threshold (S) and of the third quantity (DEC) can be programmed according to the connection class and said value of the

first quantity (INC) can be programmed according to the connection.

8. Method according to whichever claim 1 to 7, characterized by the fact that said current value (VLB) is periodically decreased by a fourth quantity, with an intervention frequency lower than the overflow cycle time of the counter defining the difference between said absolute time (CLK) and time (LST) of the previous updating of said current value (VLB).

9. Method according to claim 8, characterized by the fact that said fourth quantity is equal to the product of said third quantity (DEC), for the difference between the absolute time (CLK) on the moment of the periodical decrease and the time (LST) of the previous updating of said current value (VLB).

10. Method according to whichever claim 1, 3, 6 and 7, characterized by the fact that said current value (VLB) is assumed firstly as one half of said threshold value (S) on the arrival of a first information cell relevant to said connection.

11. Method according to whichever claim 1 to 9, characterized by the fact that said current value (VLB) is updated following the arrival of an information cell relevant to said connection without being increased by said first quantity (INC) according to the value of a fifth quantity (VD) and of a sixth quantity (S/PM).

12. Method according to claim 11, characterized by the fact that said fifth quantity (VD) is a binary value which can be modified.

13. Method according to claim 11, characterized by the fact that said sixth quantity (S/PM) is a binary programmable value.

14. Unit for the control of the information cell flow in an ATM technique telecommunication system, characterized by the fact to include:

an arithmetic unit (AU) connected to an input/output unit (I/O) through an internal data bus (DBI), said

input/output unit being connected to an external data bus (DBE);

a register file (RF) connected to said input/output unit (I/O) through said internal data bus (DBI) and an internal address bus (ARF), and connected to said arithmetic unit (AU) through said internal data bus (DBI);

a first central controller (CC) supervising the updating operations, and a second memory controller (MC) for the control of the loading/storage sequence.

15. Control unit according to claim 14, characterized by the fact of being connected to means (HTU) suitable to perform the processing of the cell flow of the ATM technique telecommunication system through a four-wire interface and a bus (LB) for the exchange of virtual path (VP) and virtual circuit (VC) indicators of the incoming cell, and a dedicated RAM memory (MPU) containing the current parameters for the execution of the control method.

16. Input unit of an ATM technique telecommunication system for the control of the cell flow through a unit (PU) according to claims 14 to 15, characterized by the fact to include a storage (MPU) containing the so-called Leaky Bucket parameter values relevant to active connections, each address block containing a record made of status fields (ST), one current value field (VLB), an (INC/DEC) field containing the value associated to the parameter to be controlled for the relevant link (VC/VP) and a field (LST) containing the time of the last updating of the current value field (VLB) of the relevant connection.

17. Unit according to claim 16, characterized by the fact that said status field /ST) is made of 4 bits where are stored the new call (NC) information, the class of the connection (CC0-CC1) underway defining said threshold values (S) and increase/decrease (INC/DEC) values, and one bit (VD) recording the infrigement of parameters controlled by different units of said control unit (PU).

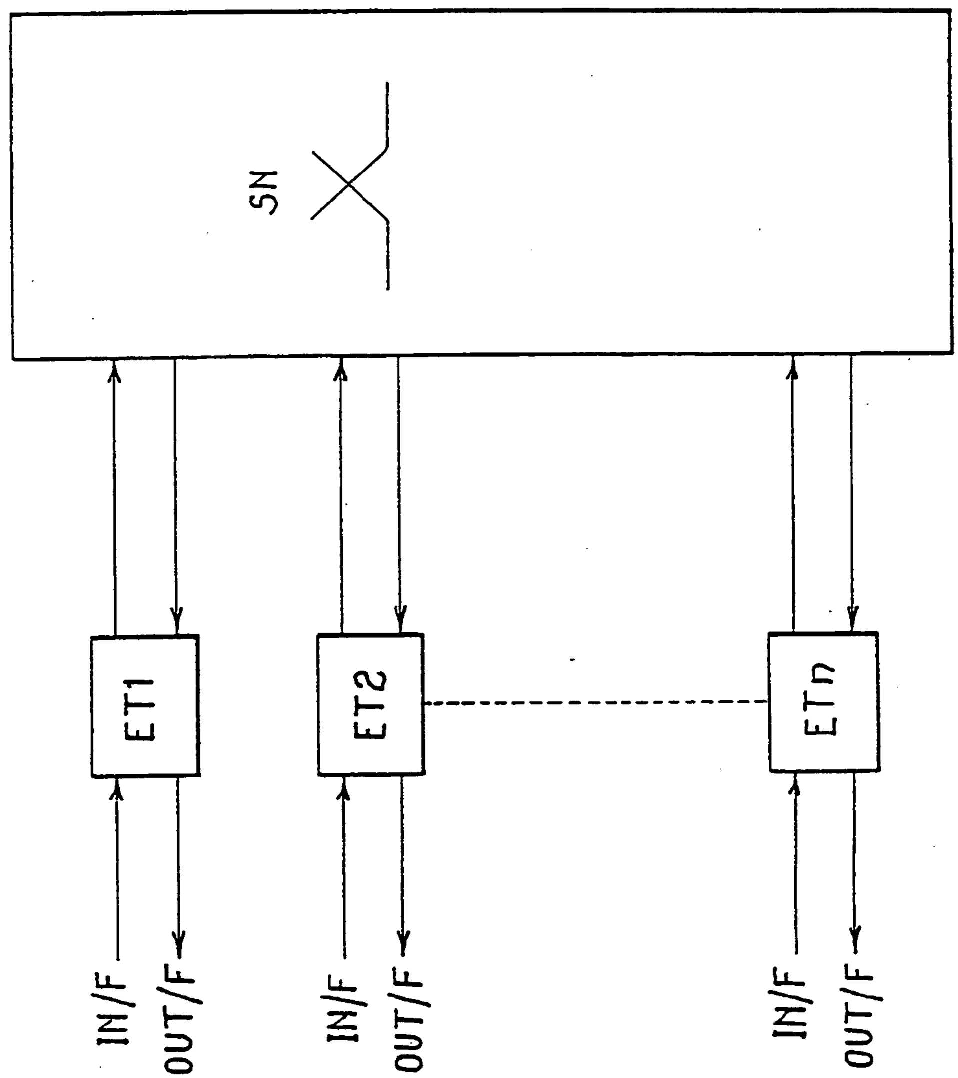
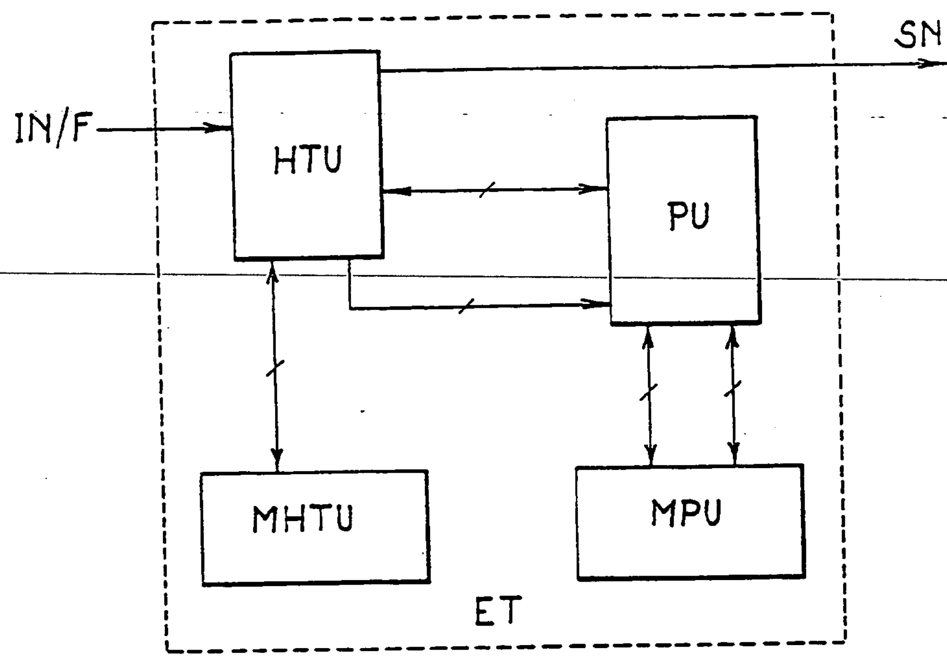


Fig.1

Fig. 2


SN
IN/F
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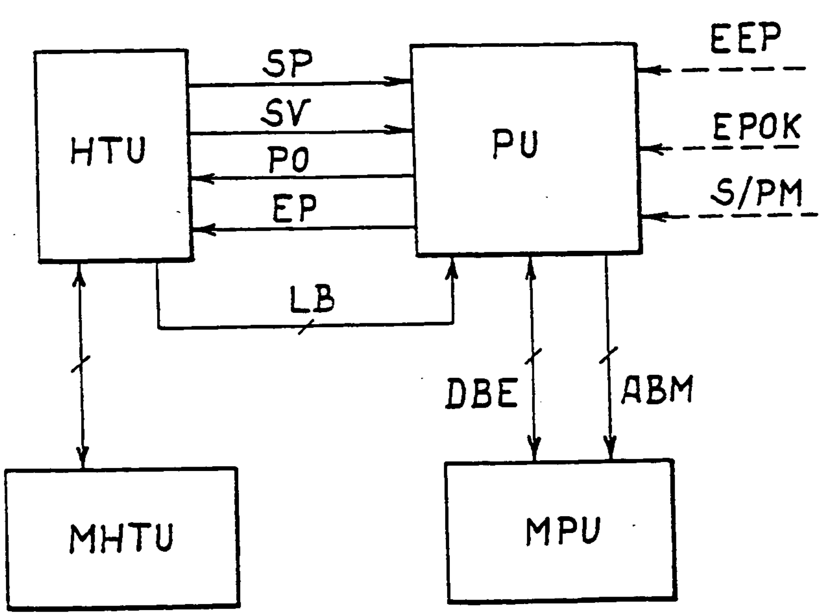
MHTU
MPU
ET

Fig. 3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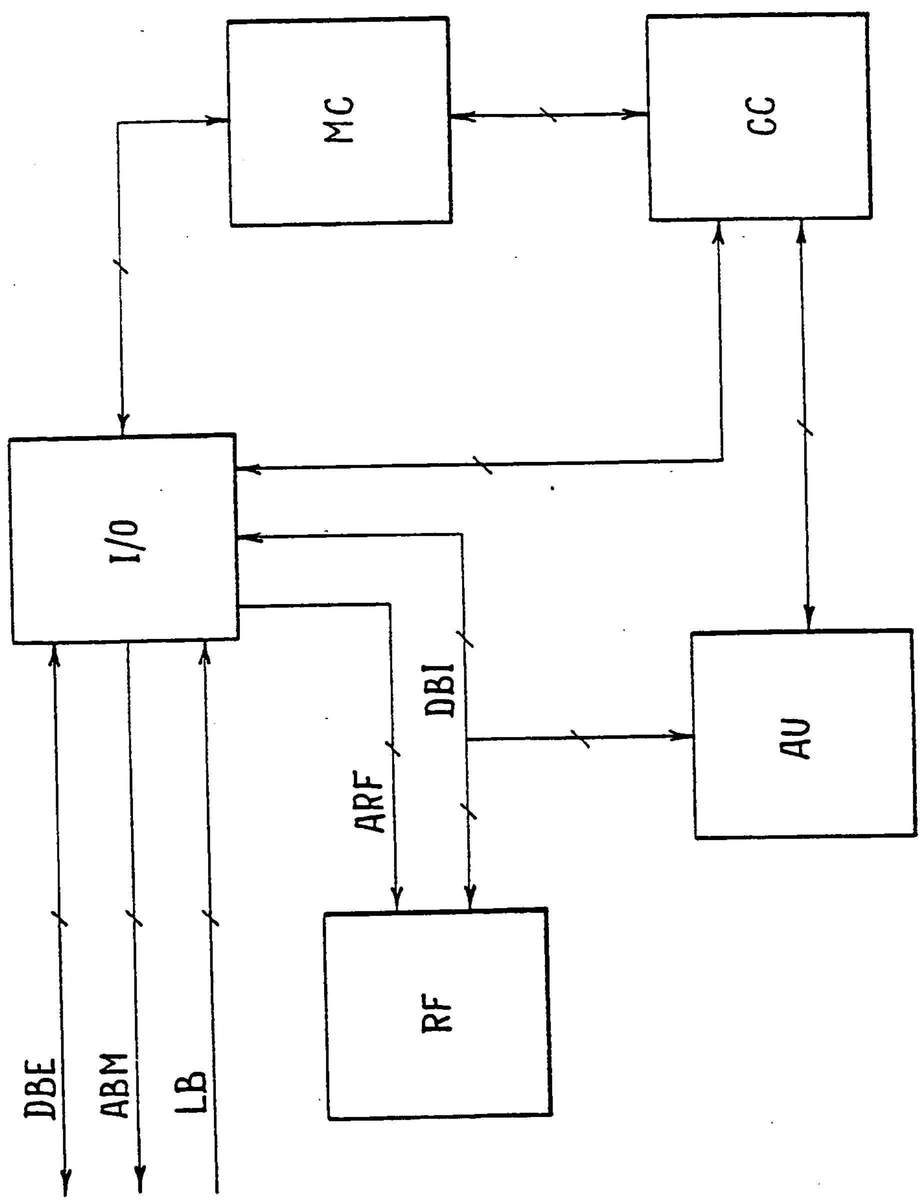

Fig.4

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Fig. 5

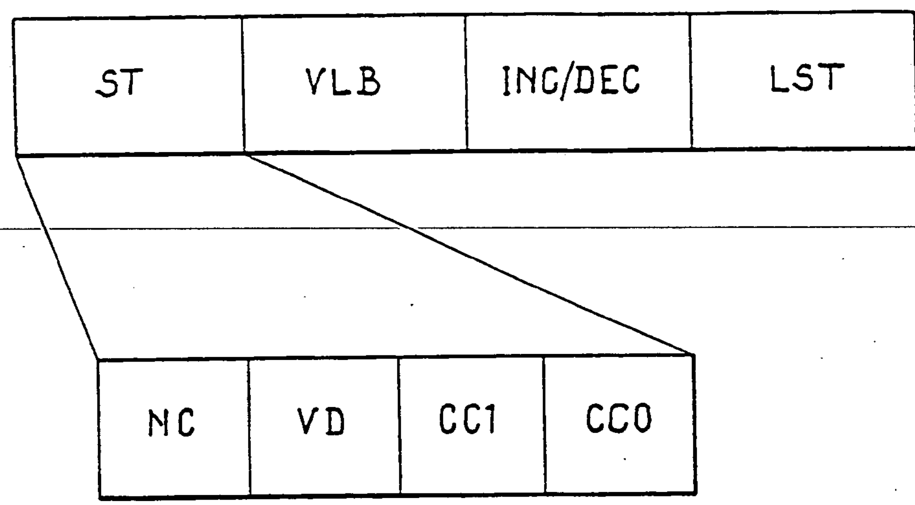
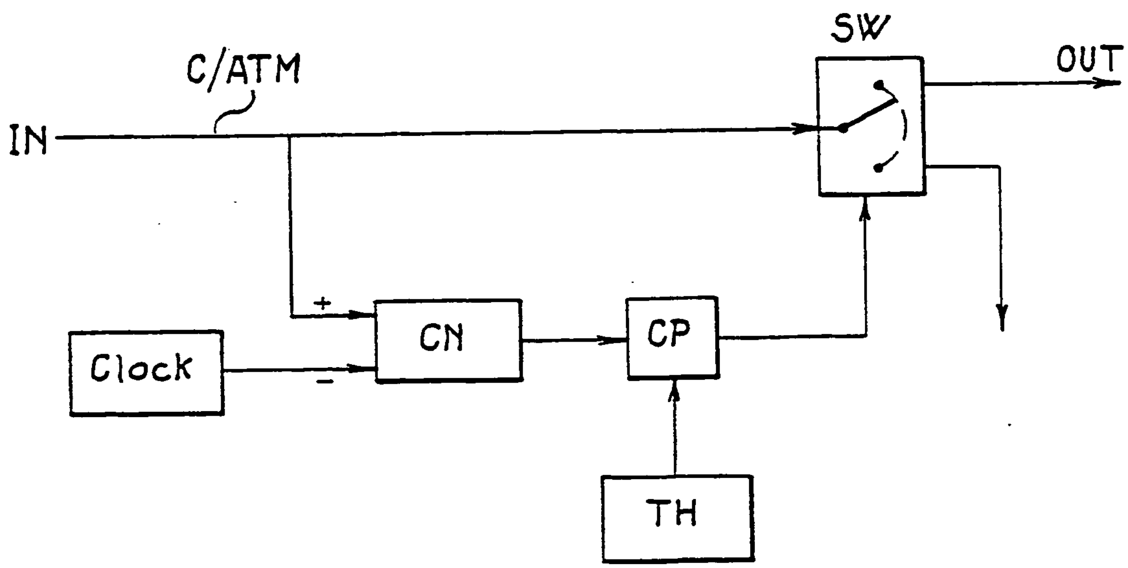


Fig. 6



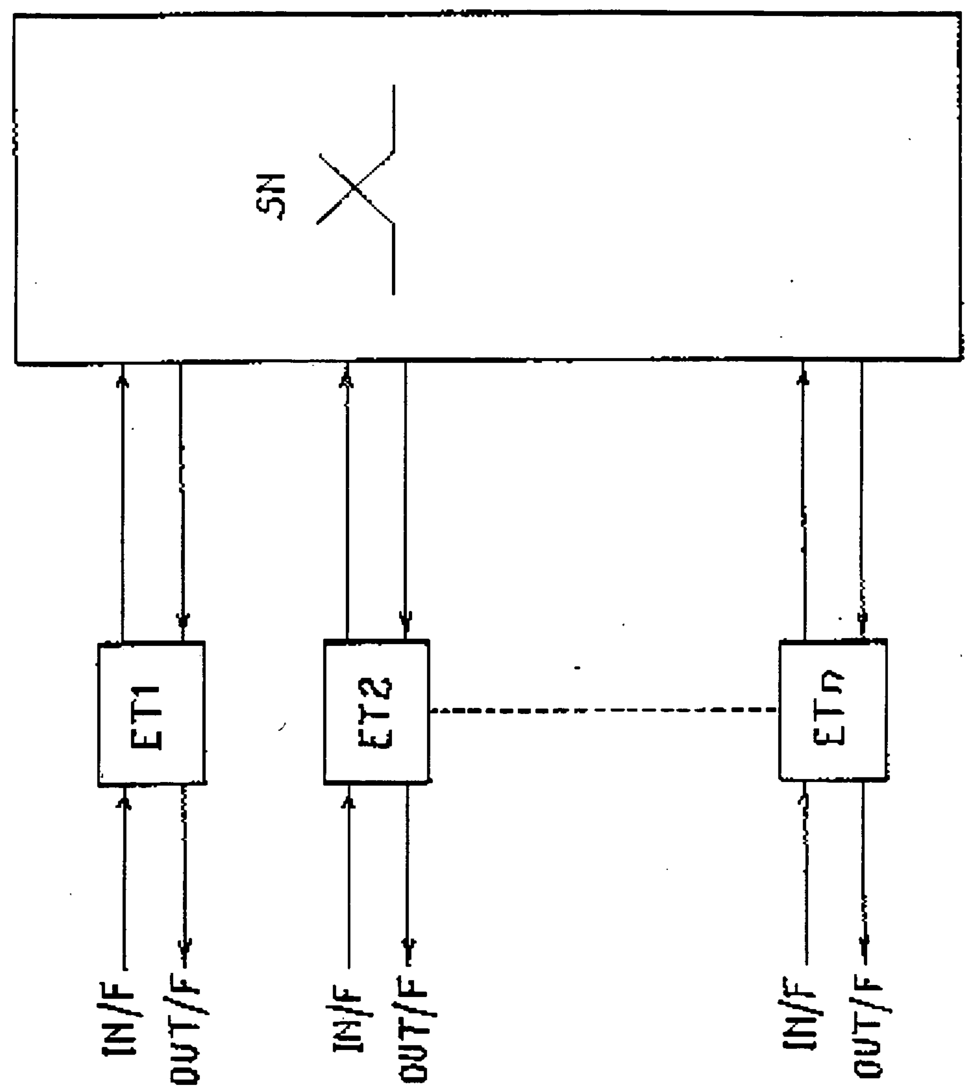


Fig. 1

Fig. 2

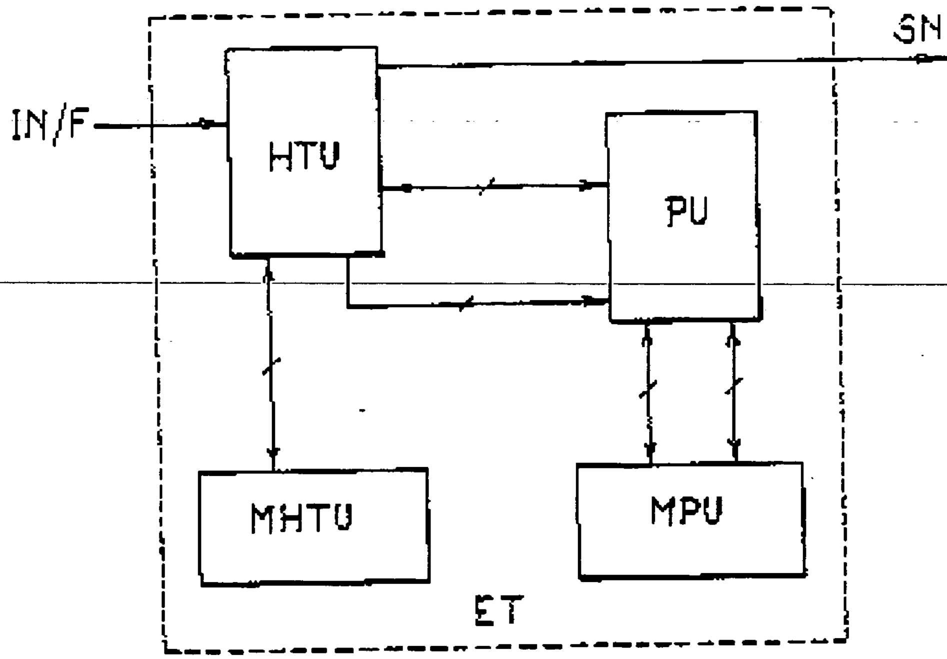

SN
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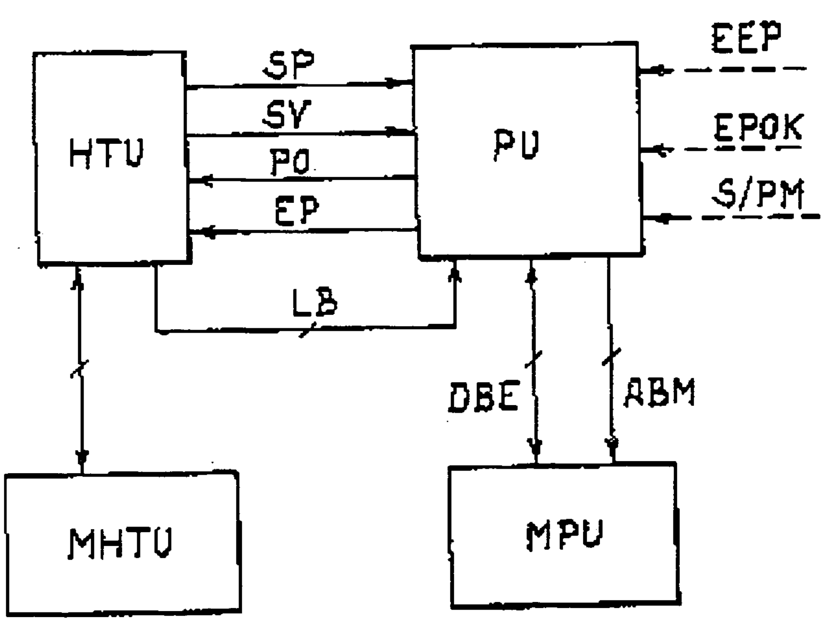
Fig. 3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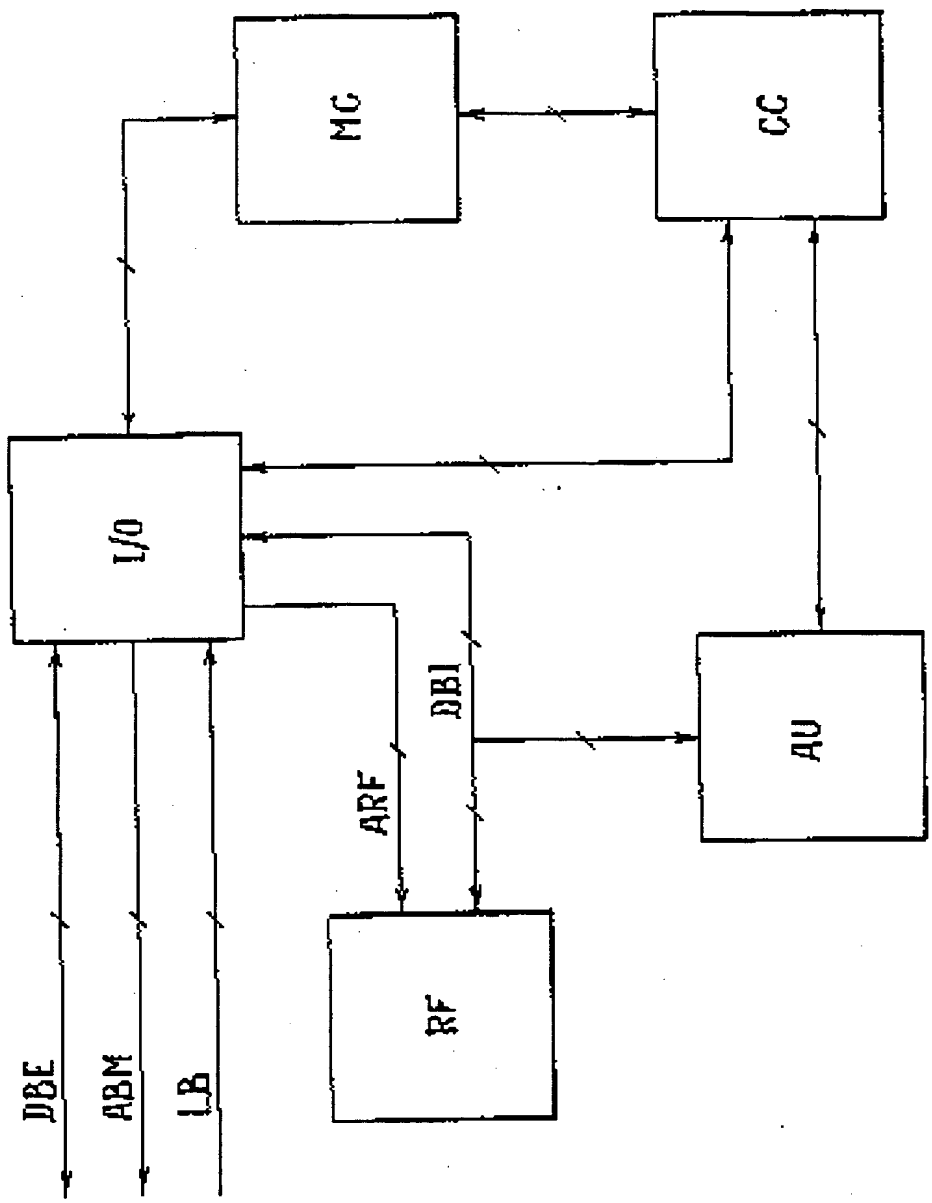


Fig.4

Fig.5

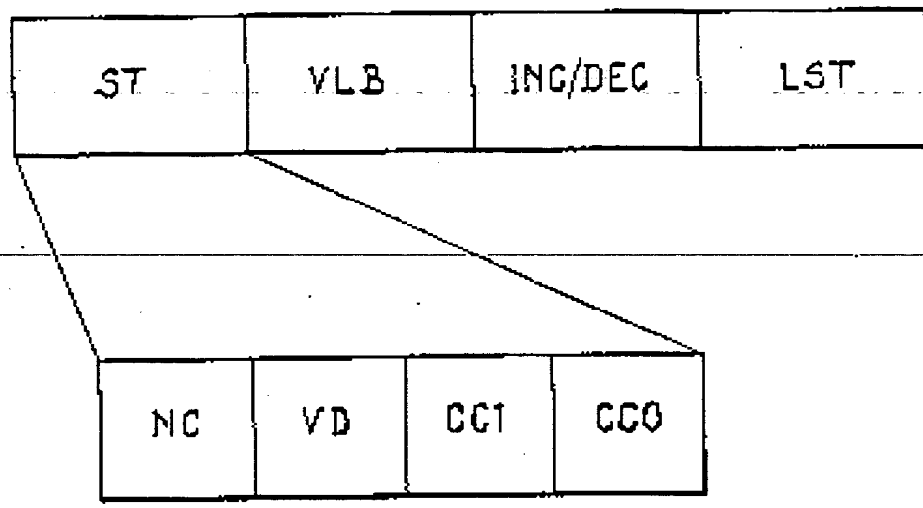
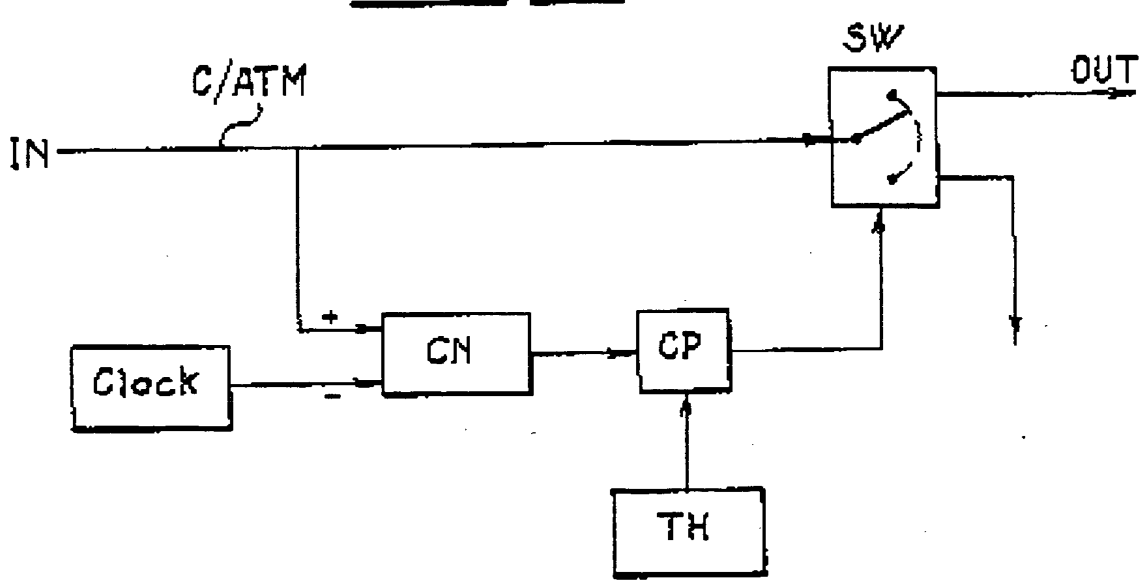


Fig.6



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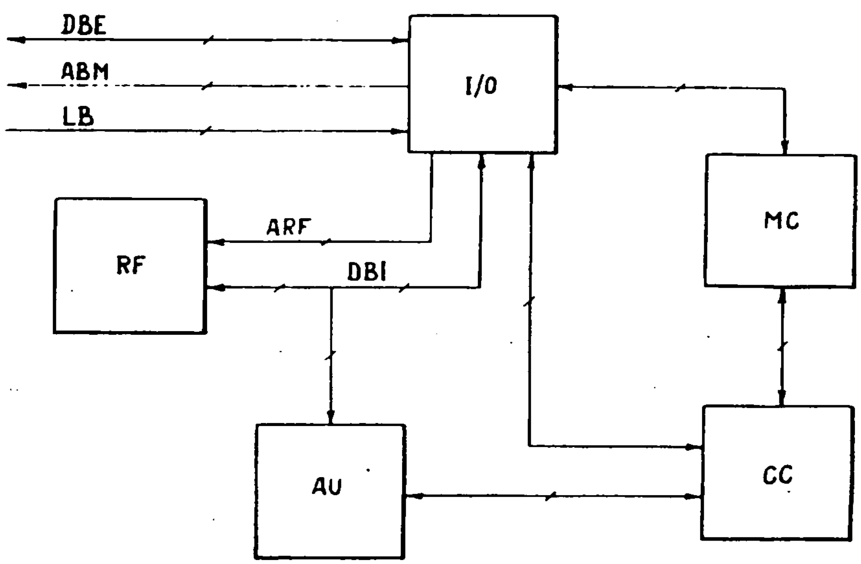
(54) Title: METHOD AND UNIT FOR THE CONTROL OF THE CELL FLOW IN A TELECOMMUNICATION SYSTEM ACCORDING TO THE ATM TECHNIQUE



(57) Abstract

Method for the control of the cell flow in a telecommunication system in ATM technique, according to the so-called "Leaky Bucket" principle, where to each active connection (VC/VP) a current value (VLB) is associated, increased by a first quantity (INC) and decreased by a second quantity, following the arrival of an information cell relating to the connection. Said value (VLB) is compared with a reference threshold (S) to decide if the cell has to be sent or not. The decrease is equal to the product of a third quantity (DEC) and the difference between the absolute time (CLK) and the time (LST) of the previous updating of said current value (VLB). The method is implemented by means of one unit (PU) including two control units (CC, MC), an arithmetic unit (AU), a register file (RF) and an input/output unit (I/O).

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AMENDED CLAIMS
[received by the International Bureau on 9 March 1993 (09.03.93); original claims 1 and 14-17 amended; claims 2 and 10-13 cancelled; remaining claims unchanged; all claims renumbered as claims 1-14 (5 pages)]

1. A method for controlling the cell flow in an ATM telecommunication system, according to the so-called Leaky Bucket principle,

where to each active connection (VC/VP) is associated a current value (VLB), to be updated only upon the arrival of an information cell relating to said connection,

said updating comprising the increase of said current value (VLB) by a first quantity (INC) upon said cell arrival and the decrease thereof by a second quantity equal to the product of a third quantity (DEC) for the length of time (CLK-LST) elapsed between two consecutive updatings of said current value (VLB),

said value (VLB) being compared with a reference threshold (S) for discarding the incoming cell when said value (VLB) exceeds said reference threshold (S),
characterized by the fact that when said value (VLB) does not exceed said reference threshold (S) after an updating:

i) a first acceptance signal (PO=1) is generated;

ii) a second acceptance signal (EPOK) from another device controlling the cell flow is checked,

iii) if said second acceptance signal (EPOK) is an enabling signal the cell is let through the system,

iv) if said second acceptance signal (EPOK) is a blocking signal the cell is discarded and a state signal (VD) is set whereby upon the next arrival of a cell of the concerned active connection said value (VLB) will only be decreased by the product of said third quantity (DEC) for the length of time elapsed (CLK-LST), with said state signal (VD) being reset at the same time if said second acceptance signal (EPOK) is an enabling signal.

2. A method as claimed in claim 1, characterized by the fact that the value of said threshold (S) is variable.

3. A method as claimed in claim 1, characterized by the fact that the value of said first quantity (INC) is variable.

4. A method as claimed in claim 1, characterized by the fact that the value of said third quantity (DEC) is variable.

5. A method as claimed in claims 2, 3 or 4, characterized by the fact that both the values of the said threshold (S) and said first quantity (INC) are programmable in accordance with predetermined connection classes negotiated at the call set-up, and that the value of said third quantity (DEC) is programmable in accordance with the type of the connection.

6. A method as claimed in claims 2, 3 or 4, characterized by the fact that both the values of the said threshold (S) and said third quantity (DEC) are programmable in accordance with predetermined connection classes negotiated at the call set-up, and that the value of said first quantity (INC) is programmable in accordance with the type of the connection.

7. A method as claimed in claims 2, 3 or 4, characterized by the fact that said current value (VLB) is firstly set to one half of said threshold value (S) on the arrival of a first information cell relevant to such connection.

8. A method as claimed in claims 1 to 7, characterized by the fact that said current value (VLB) is periodically decreased by a fourth quantity, with an intervention frequency lower than the overflow cycle time of the counter defining the difference between said absolute time (CLK) and the time (LST) of the previous updating of said current value (VLB).

9. A method as claimed in claims 2, 3 or 4, characterized by the fact that said fourth quantity is equal to the product of said third quantity (DEC) for the difference between the absolute time (CLK) on the moment of

the periodical decrease and the time (LST) of the previous updating of said current value (VLB).

10. A device for controlling the cell flow in an ATM switching node comprising a connection network (SN) and a number of exchange termination units (ETi) connected thereto, each receiving incoming cell flows (IN/F) and transmitting outcoming cell flows (OUT/F), <u>characterized by the fact that</u> each of said exchange terminating units (ETi) comprises:

- a header translation and processing unit (HTU) receiving the incoming cell flow (IN/F) for converting the cell format and selectively forwarding the cells to the connection network (SN);

- a routing memory (MHTU) connected to said processing unit (HTU) ;

- a parameter memory (MPU) storing at least one traffic parameter relevant to the active connections;

- at least one policing unit (PU) connected to said parameter memory (MPU), for checking whether the incoming cells meet said at least one traffic parameter and accordingly controlling the forwarding of the cells to the connection network (SN), said at least one policing unit (PU) comprising:

an input/output unit (I/O) connected to said parameter memory (MPU);

a register file (RF) storing the traffic parameters for connection classes and connected to said input/output unit (I/O) through an internal data bus (DBI) and an internal address bus (ARF);

a memory controller (MC) for controlling the loading and storage sequence to and from said parameter memory (MPU);

an arithmetic unit (AU) connected to said internal data bus (DBI) for carrying out the updating operations of a current value (VLB) associated to each active connection (VC/VP);

a central controller (CC) supervising the updating operations of said current value (VLB).

11. A device as claimed in claim 10, characterized by the fact that said arithmetic unit (AU) carries out the updating operations of the current value (VLB) associated to each active connection (VC/VP) according to the formula:

$$VLB = VLB + INC - (CLK - LST) \cdot DEC$$

where

VLB is the current value;

INC is the value by which the current value VLB is increased when a new cell of that connection arrives;

DEC is the value by which the counter is decreased at each cell time;

CLK is the absolute time; and

LST is the time of arrival of the last cell relevant to the considered active connection.

12. A device as claimed in claims 10 or 11, characterized by the fact that said at least one policing unit (PU) is connected to said header translation and processing unit (HTU) through a four-wire interface and a bus (LB) for the exchange of virtual path (VP) and virtual channel (VC) indicators of the incoming cell.

13. A device as claimed in claims 10 or 11, characterized by the fact that said parameter memory (MPU) is a RAM memory with address blocks containing a record made of status fields (ST), one current value field (VLB), one field (INC/DEC) containing the value associated to the parameter to be controlled for the relevant connection (VC/VP), and one field (LST) containing the time of the last updating of the current value field (VLB) of the relevant connection.

14. A device as claimed in claim 13, characterized by the fact that said status field (ST) comprises four bits, one bit (NC) storing a new call information, two bits (CC0-CC1) storing the class of connection which in turn defines said threshold value (S) and such increase/decrease values

(INC, DEC), and one bit (VD) for recording the infringement of parameters controlled by additional control units.

STATEMENT UNDER ARTICLE 19(1)

Amended claims 1 to 9 are directed to a method wherein claim 1 has been modified for a correct dependancy of original claims 8 and 9, previously objected under Rule 13(1 to 3) for lack of invention unit in respect of the original main claim. The claim preamble has been based on what appears to be known by EP-0 381.275.

Amended claims 10 to 14 are directed to a device for controlling the cell flow in an ATM switching node with a preamble defining the "environment" in which such device operates.